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PROCESS AND DEVICE FOR THOROUGHLY CLEANING SURFACES

[Verfahren und Vorrichtung zum Feinstreinigen von Oberflächen]

Horst Kunze-Concewitz

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INVENTOR	(72):	Horst Kunze-Concewitz
APPLICANT	(71):	Horst Kunze-Concewitz
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Description

The invention relates to a process for thoroughly cleaning surfaces with water vapor according to the preamble of Claim 1 and a device for carrying out said process according to the preamble of Claim 15.

Conventional cleaning processes are based on a case in which the surface of an object or substrate to be cleaned is cleaned by means of dipping into a wet basin filled with detergents and, for example, with ultrasonic support or by means of immersion of the substrate in a steam atmosphere or, as the case may be, by means of mechanical processing of the surface, e.g., by means of brushes, by means of spraying water or detergents at high pressure from spray nozzles or by means of vibration via oscillation (megasonics).

For chip manufacture in particular, planarizing is a process step that is accorded an ever greater significance in the course of constant miniaturization of structures. The structured surfaces of a substrate (e.g., of a silicon wafer) are ground flat or lapped flat by means of a chemical/mechanical polishing step, with the use of a fine polishing agent (slurry). Said polishing agents feature an extremely small particle size, which entails the disadvantage that individual polishing particles remain adhered to the processed surface after the polishing sequence and to some extent are incorporated into the surface. After the polishing sequence, the surface must be completely freed of polishing agents and other contaminants in order to further process the substrate.

As already set forth above, attempts are made to remove residual polishing agent by means of /2[*]
brushes, water and the high-pressure spraying of water up to 50 bar. Brushes have the intrinsic disadvantage of requiring constant wetting with water and of gradually getting clogged with polishing agent that has been carried away. It therefore is necessary to regularly replace the brushes, which, in turn, is associated with the disadvantage that engaging the cleaning station while replacing brushes contaminants the cleaning station. In addition, the mechanical processing with brushes of a surface to be

[*] [Numbers in the margin indicate pagination of the original document.]

cleaned is not free from the risk that the surface will be damaged, scratched, in particular. As a rule, a cleaning process with brushes is followed by an additional cleaning process in which water is sprayed under high pressure. In order to attain good results, a surface to be cleaned must be sprayed a certain amount of time and checked several times, resulting in long cleaning times.

In the following, the disadvantages of the conventional process shall be listed once more. Apart from a high level of brush wear and consequent high costs for brushes, frequent brush changing entails a necessary engagement with the machine and, as a consequence, machine downtime. The clogging of brushes raises the concern of damage to the surface caused by scratching, and permanently maintaining wet brushes (brush material is composed of PFA sponge) entails a high level of consumption of deionized water (DI water). In addition, the construction of a cleaning chamber with brush cleaning for two-sided substrate cleaning is complicated and expensive. The brush pressure of sponge brushes cannot be set in a reproducible manner. In high-pressure cleaning the risk exists of electrostatic charging of the substrate, since nonconductive Di-H_2O is employed. With megasonic cleaning the surface cannot be /3
fully cleaned precisely after polishing processes.

Therefore, the underlying purpose of the invention is to provide a process and/or a device with which a contaminated surface can be cleaned more easily, more economically and more quickly, and also with a greater level of assurance against damage.

This problem is solved according to the invention in that for the aforementioned process, at least one steam nozzle is brought into the immediate proximity of the surface and in that the steam is conducted by means of the nozzle in a targeted manner upon the surface to be cleaned, with the surface to be cleaned being wetted with water simultaneous to or prior to being sprayed with steam.

The device according to the invention features the considerable advantage that a surface to be cleaned is not processed mechanically, and adhered particles of polishing paste to be removed are first loosened

by thermal energy introduced by the steam. The differing levels of thermal energy absorption of substrate and particles to be loosened and tension evoked by means of different coefficients of expansion loosens the bond between particle and substrate, lifting the particles from the surface to be cleaned. If wet steam is used in lieu of superheated steam, particles are additionally loosened by means of the transmission of impulsive force. Utilized in this connection is the kinetic energy (ultrasonic energy) during the impact of liquid droplets. An additional advantage consists in the fact that introducing steam to a water film situated on the surface locally vaporizes the water to an extent, with the steam bubbles collapsing afresh immediately afterward or bursting on the surface of the water film. This effect of impulsive force on the particles likewise leads to a loosening. Particles can swim up to the surface in the water film, which causes them to be easy to remove. The water film can either be deposited separately or be formed from condensate.

The process according to the invention can be employed not only for even or planar surfaces, but also for deep structures as found, for example, in the manufacture of elements for micromechanics. A transporting-away of lifted particles can be carried out either by means of steam conducted to the surface, by means of condensate and/or by means of additional sprayed-on water. This is of advantage, in particular, for a very thin substrate where only a very limited amount of condensation occurs. /4

In an improvement, a provision is made that, e.g., by introducing a foreign gas, e.g., nitrogen or similar, or by using superheated steam, the surface can be subsequently dried. Drying stains are prevented in this way. It is regarded as particularly important that a lifting of particles is brought about by means of an impulse force effect (kinetic energy), by means of differing levels of thermal expansion (thermal energy) and by means of an impulsive force effect (vaporizing of water and bursting of gas bubbles). In this connection, the blowing-on of steam in a water film is preferred.

Advantages are seen in the fact that DI water is used, to which can be added alcohols, detergents, solvents or similar. Foreign gas, e.g., nitrogen or similar, can be added to the steam. A particular area of application is regarded in the cleaning that follows the CMP process, yet also in the manufacture of LCD products, in hard disk fabrication, micromechanics or other processes requiring highly pure surfaces.

The aforementioned problem is solved with a device according to the invention by means of the provision of at least one steam nozzle directed at a surface to be cleaned and also of an arrangement for producing a water film on the surface to be cleaned.

For said device, the surface, for example, of a silicon wafer is wetted, with steam subsequently being blown into said water film. The surface is cleaned in a non-contact manner by means of this device according to the invention, with the aforementioned force forming the primary contribution for detaching particles of dirt. Wetting with water can occur, for example, by means of spraying on steam, which then condenses.

According to the invention, a transport device is provided, by means of which the objects, or substrates, the surface of which must be cleaned, are rotated and/or transported. The objects are, e.g., flat disks in [the manufacture of] silicon wafers, which are transported through the cleaning station in a non-contact manner in a continuous process. In the process, both the top and bottom are cleaned. The two sides can be cleaned simultaneously or in succession. In this connection, it is preferable for the object to rotate on a cushion of steam and/or water and to be held in a non-contact manner in this way. The position is fixed by means of pins or rollers, which engage the edge of the disk. Correspondingly arranged nozzles on the transport device, which are directed toward the bottom of the disk, set the substrate into rotation and/or transport same through the cleaning station. The oblique angle of impact of the fluid leaving the nozzles is selected such that a disk is moved in any case and is also cleaned if

necessary. The impacting fluid therefore serves as a transport agent, cleaning agent and as an agent for carrying away detached particles. Drainage of the fluid is facilitated, for example, by means of cross /6
grooves, or diagonal grooves in the transport device.

A drying section, in which the substrate is dried, can be attached to the section of the cleaning station in which cleaning occurs. In this connection the substrate preferably is set into rotation (1500 rpm), causing the adhering water film to be centrifuged off; in addition, drying can be supported by means of superheated steam. At the outlet of the cleaning station, individual substrates can be inserted into magazines or cassettes for transport away.

The advantages of the process according to the invention and of the device according to the invention are the substantially improved cleaning results at higher water temperatures, shorter processing times and thus higher turnovers, non-contact cleaning and consequent absence of mechanical stress to the substrate surface, no consumable materials such as brushes etc., and therefore substantially lower operating costs, no engagement in the cleaning chamber and thereby no downtimes or risk of contamination, no required cleaning of the processing chamber since this is automatically also cleaned with steam, smaller facility dimensions and smaller cleaning room requirement, simpler process chamber construction, reproducible cleaning results in contrast to conventional processes, in which brushes wear out, easy to integrate in a cluster with other facilities, environmentally friendly cleaning, since there are no solvents, e.g., for cleaning of the polisher in CMP process.

Additional advantages, features and details of the invention are yielded from the claims and from the following description in which especially preferred embodiments are expounded upon with reference /7
to the drawings. In this connection, features mentioned in the claims and in the description and illustrated in the drawings can be essential to the invention, in each case, individually, or in any combination. Shown in the drawings are:

Figure 1 a basic sketch of a device for producing steam;

Figure 2 a process procedure for coating and planarizing a silicon wafer;

Figure 3 a first embodiment of the cleaning device according to the invention;

Figure 4 a second embodiment of the cleaning device according to the invention;

Figure 5 a first embodiment of the transport device according to the invention;

Figure 6 a second embodiment of the transport device according to the invention;

Figure 7 a top view of the device according to Figure 6 in the direction of arrow VII;

Figure 8 a third embodiment of the transport device according to the invention;

Figure 9 a fourth embodiment of the transport device according to the invention;

Figure 10 a fifth embodiment of the transport device according to the invention;

Figure 11 a schematic diagram of a cleaning station;

Figure 12 a representation of a first process for cleaning a contaminated surface; /8

Figure 13 a second process for cleaning a contaminated surface;

Figure 14 a third process for cleaning a contaminated surface;

Figure 15 a top view of the representation according to Figure 14 in the direction of arrow XV.

Illustrated in Figure 1 is a basic sketch for the preparation of steam to be used for cleaning a contaminated surface. In this connection, the reference number (1) denotes a spray nozzle, from which steam (16) escapes as superheated steam or wet steam. The nozzle (1) is connected by means of a conduit (17) to a steam boiler (5). Provided in this connection, in succession, in the conduit (17) are a steam valve (4), a connection (12') for introducing foreign gas, e.g., in order to introduce nitrogen (N_2), a connection (11') for introducing a foreign agent, e.g., alcohol or similar, a clarifying filter (3) and also a flow reducer (2), e.g., in the form of a throttle. Situated in the steam boiler (5) is deionized water (18) introduced either by means of a direct water inlet (8), e.g., for non-continuous operation, or by means of

a feed (19). Said feed (19) is connected to a water connection (15) and also to a water force pump (14) and a water inlet valve (13) for continuous operation. Situated in the hot-water bath of the steam boiler (5) is a heater (6), an electric heater, in particular, by means of which the hot-water bath is heated by a heater control (7) having a temperature sensor (20). The steam boiler (5) is further provided with a connection (12) for introducing foreign gas and also with a connection (11) for introducing a foreign agent, a steam pressure switch (10) and also an overpressure valve (9). In this way, both superheated /9
steam and wet steam can be produced, e.g., by supplying water via the connection (11').

In wafer manufacture, the structured surface of a silicon wafer (21) is coated with a planarizing layer composed, e.g., of SiO_2. The structured surface, which has been manufactured by means of exposure and a subsequent etching process, is illustrated in Figure 2a. Figure 2b shows the surface coated with a planarizing layer (22), with it being clearly identifiable that the surface of said planarizing layer (22) is uneven. By means of a subsequent grinding or lapping process (CMP process), the planarizing layer (22) is ground only until the recesses (23) of the surface of the silicon wafer (21) are filled. Here, highly fine polishing agents (slurry) are used with, however, individual particles of polishing agent still adhering to the surface or being embedded in recesses of the surface (60) after the grinding process has ended. The surface illustrated in Figure 2c and denoted as (24) now must be decontaminated, i.e., relieved of any contamination whatsoever, for further processes.

Figure 3 shows a first embodiment of the cleaning device according to the invention, which is designed, e.g., to accept silicon wafers (21) featuring a round discoid configuration. The silicon wafer (21) or substrate (21) is attached in the area of the edges in at least three diabolo-shaped drive rollers (25), with the drive rollers being borne in a rotating manner in the direction of the arrow (26). In this way the substrate (21) can be moved without damage to and without contacting the surface (24). In this connection, the two surfaces (24) are sprayed from above and from below with steam (16) by means

of spray nozzles (1). Each spray nozzle (1), respectively, is radially maneuverable by means of a suitable device in the direction of the arrows (27), or in another way, between the center (28) and the edge of the /10 substrate (21), and features a clearance of approximately 1 mm from the surface (24). In this way the entire surface (24) can be processed with steam (16).

Steam (16) escaping from the nozzle (1) bounces against the surface (24), such that kinetic energy causes contaminants adhering to, or in recesses of, the surface (24) to be loosened. If wet steam (16) is sprayed on the surface, then contaminants are loosened by means of occurring liquid droplets, or, by means of the kinetic energy thereof. In addition, water vapor condenses on the surface and, to an extent, is vaporized afresh by means of subsequent steam, with the steam bubbles collapsing afresh immediately thereupon or bursting on the surface of the substrate. This impulsive force leads to a further loosening of the particles. In addition, the substrate (21) and the individual particles are heated in a differing manner, such that thermal tension arises, which causes further loosening.

The advantage of this process according to the invention lies in the very limited media consumption, with impulse effect, thermal effect and impulsive force effect causing a very effective cleaning. In addition, the action of the cleaning force is simple to control by means of targeted changes in steam pressure, quantity of steam marshaled, steam temperature, clearance between steam nozzle and substrate surface and thickness of the water film, as well as by means of the dosing of foreign agents or dosing of foreign gas. Cleaning occurs by means of deionized water such that disposal problems do not arise and the overall process is environmentally friendly. Drying can occur by blowing superheated steam (16) or by supplying foreign gas. Pressure control occurs via a water temperature at a temperature range above 100°C up to approximately 200°C, corresponding to a pressure range of up to approximately 10 bar.

Figure 4 shows a different embodiment of the cleaning device according to the invention, in which /11

the substrate (21) is clamped in a rotating holder (29). Said rotating holder (29) can also accept a substrate (21) that is not circular, and grasps same in the area of the edges thereof. In this embodiment, the nozzle (1) cleans the surface (24) facing upward.

Figure 5 shows a first embodiment of a transport device (30) for moving the substrate (21) in the direction of the arrow (31). For this, the transport device (30) features a steam channel (32), the surface of which is provided with a multitude of steam nozzles (33). Said steam nozzles (33) are slightly inclined in the direction of the arrow (31), such that steam (16) escaping from a steam channel (32) forms a steam cushion (34) under the substrate (21), transporting same in the direction of the arrow (31). A substrate (21) can be moved in this way through a cleaning station in a non-contact manner in a continuous process, with the substrate (21) hovering on a steam/water cushion (34). Lateral guidance occurs by means of boundary rails, as illustrated in Figure 7.

The transport device (30) also features, apart from the transport sections illustrated in Figure 5, sections (36) in which the substrate (21) is rotated, which is illustrated in Figure 6. In said sections (36), nozzles (37) likewise are provided, the escape direction of which, however, is essentially inclined upward and tangential about the center (28) and, if need be, as illustrated in Figure 6, progresses outward in an inclined manner in the direction of the edge of the substrate (21). In this way, a substrate is rotated in the direction of the arrows (38) about the center (48). Positioning of the substrate (21) occurs by means of boundary pins (39) arranged in a retractable manner in section (36). If the boundary pins (39) are extended, as illustrated in Figure 6 or 7, the substrate (21) is prevented from further
transport in the direction of the arrow (31) and is held fast in the section (36). The boundary pins (39) /12
also can, for their part, be borne in a rotating manner. Cleaning of the surface(s) (24) of the substrate (21) can then occur in this section (36).

Figure 8 shows a modified embodiment of a transport section (40) of a transport device (30), with the substrate (21) being arranged, in essence, between two steam channels (32) and both surfaces being impinged upon by steam (16) escaping from steam nozzles (39). The substrate (21) therefore is embedded between two steam cushions (34) and is moved in the direction of the arrow (31).

Illustrated in Figure 9 is an alternative cleaning section (41) of the transport device (30) in which a substrate (21), as described with Figures 6 and 7, is held fast by means of boundary pins (39) and rotated by means of steam nozzles (37). In this connection, the steam nozzles (37) can simultaneously serve as spray nozzles (1), as already described also for the embodiments of Figures 6 and 7, i.e., in order to clean the surfaces (24) of the substrate (21). Detached particles of dirt and accumulating water can, as illustrated in Figure 10, be led away by means of channels (42) provided in the lower steam channel (32). The channels (32 and/or 42) are in an inclined arrangement for this purpose.

Figure 11 shows, diagrammatically, a continuous arrangement of this type in which a substrate (21) is placed on the transport device (30) and transported in the direction of the arrow (31). In this connection, the section (35) serves for transporting and the section (36) serves for cleaning the substrate (21). Diagrammatically illustrated with (43) is a spin dryer, in which a substrate (21) is set into a rapid rotation in the direction of the arrow (44) (approximately 1500 rpm). A substrate (21) is removed by corresponding manipulators (45) from the spin dryer (43) and deposited, e.g., in cassettes or magazines (not illustrated), and is prepared for further transport in the direction of the arrow (31). /13

Illustrated in Figure 12 is a cleaning process for which a substrate (21) is sprayed by means of a water lance (46) with water (18), such that a water film (47) forms on the surface (24) of the substrate (21). By means of the water lance (46), water (18) is rendered to the center (28) of the surface (24), such that water (18) drains off as a water film (47) in the direction of the arrows (48). Simultaneously, the spray nozzle (1) travels in the direction of the arrows (27) over the surface (24) and

sprays steam (16) directly in the water film (47). In this connection, steam bubbles form in the water film (47), which either immediately collapse anew or burst on the surface of the water film (47). Apart from the impulse effect of the water vapor (16), the particles (49) also undergo the impulsive effect of said steam bubbles and, in this way, are loosened or detached from the surface (24). They then are transported away with the water film (47) as it flows away.

For the embodiment of Figure 13, the substrate (21) is arranged in an inclined manner at an angle (α) and is transported by means of transport rollers (50), of which only two are illustrated, in the direction of the arrow (31). Here also, water (18) is deposited by means of the water lance (46) in order to form a water film (47) on the surface (24) of the substrate (21). Water vapor (16) is blown into said water film /14
(47) by means of the spray nozzle (1), as in the embodiment of Figure 12. In this connection, the spray nozzle (1) is moved orthogonal to the plane of projection or the spray nozzle (1) can be designed as a flat-spray nozzle, as illustrated in Figure 15.

In the embodiment of Figure 14, the substrate (21) is arranged in a level manner and likewise is transported by means of rollers (50) in the direction of the arrow (31). Here also, water (18) is deposited by means of the lance (46) in order to form a water film (47) on the surface (24) and steam (16) is blown into the water film (47) by the nozzle (1). The top view, illustrated in Figure 15, shows that both the water lance (46) and the nozzle (1) are designed as flat-spray nozzles. This arrangement is exceptionally suited to the continuous process, whereby the substrate (21) is treated gently.

In conclusion, reference shall be made to the fact that this process and a device of this type can be retrofitted for an existing grinding facility in a trouble-free manner and can readily replace existing cleaning devices.

Claims /15

1. Process for thoroughly cleaning a contaminated surface (24) with water vapor (16), characterized in that at least one steam nozzle (1) is brought into the immediate proximity of the surface (24) and in that steam (16) is conducted by means of the nozzle (1) in a targeted manner upon the surface (24) to be cleaned, with the surface (24) to be cleaned being wetted with water (18) simultaneous to or prior to being sprayed with steam (16).

2. Process according to Claim 1, characterized in that superheated steam (16) or wet steam (16) is used.

3. Process according to one of the preceding claims, characterized in that deionized water (18) is used.

4. Process according to one of the preceding claims, characterized in that added to the steam (16) and/or to the water (18) is a different gas, e.g., nitrogen (N_2), and/or a different liquid, e.g., alcohol, detergents, etc.

5. Process according to one of the preceding claims, characterized in that the composition of the steam (16) and/or of the water (18) is changed during the cleaning process.

6. Process according to one of the preceding claims, characterized in that the phase of the steam (16) is changed during the cleaning process.

7. Process according to one of the preceding claims, characterized in that the cleaning process occurs from the center (28) of the surface (24) to be cleaned in the direction of the edges thereof. /16

8. Process according to one of the preceding claims, characterized in that the surface (24) to be cleaned is set into rotation.

9. Process according to one of the preceding claims, characterized in that the steam (16) and/or the liquid (18) is deposited orthogonal to the surface (24) or oblique to the surface (24), in the direction of the edges thereof.

10. Process according to one of the preceding claims, characterized in that after the cleaning process, the surface (24) is dried by means of superheated air and/or superheated steam (16) or by means of a spin dryer centrifuge.

11. Process according to one of the preceding claims, characterized in that cleaning of the contaminated surface (24) occurs in a cleaning station, a continuous station, in particular.

12. Process according to one of the preceding claims, characterized in that steam (16) is sprayed on the surface (24) at a pressure of up to 10 bar.

13. Process according to one of the preceding claims, characterized in that it is adopted for CMP processes, mask fabrication, film manufacture, LCD production, hard disk fabrication, micromechanics, read heads for hard disks, etc.

14. Device, in particular, to carry out a process according to one of the preceding claims, /17
characterized by means of at least one steam nozzle (1) directed at a surface (24) to be cleaned and also by an arrangement for producing a water film (47) on the surface (27) to be cleaned.

15. Device according to Claim 14, characterized in that a transport device (30) is provided for the objects featuring the surface (24) to be cleaned, flat discoid objects (21) in particular.

16. Device according to Claim 15, characterized in that said transport device (30) transports the objects (21) in a non-contact manner.

17. Device according to Claim 15 or 16, characterized in that the transport device (30) sets the objects (21) in rotation and/or transports same through a cleaning station.

18. Device according to one of Claims 15-16, characterized in that the upper side of the transport device (30) features steam and/or liquid nozzles (33, 37), which serve to produce a transport cushion (34) for the object (21).

19. Device according to Claims 17 and 18, characterized in that the direction of discharge of the nozzles (33, 37) faces the direction of rotation or transport.

20. Device according to one of Claims 15-19, characterized in that the transport device (30) features an arrangement (42), for conducting water, in particular, with which dissolved contaminants (49) are carried off.

21. Device according to one of Claims 15-20, characterized in that the transport device (30) is /18
provided with cleaning nozzles (37), which conduct steam (16).

22. Device according to one of Claims 15-21, characterized in that the transport device (30) features retractable retaining elements (39), in particular, that engage the object (21) in a lateral manner, e.g., pins, rollers or similar.

23. Device according to one of Claims 14-22, characterized in that the arrangement for producing a water film (47) is a spray nozzle (46), a flat-spray nozzle in particular.

24. Device according to Claim 23, characterized in that the spray nozzle (46) for liquid and the steam nozzle (1) are directed essentially toward the same position on the surface (24) to be cleaned.

25. Device according to one of Claims 14-24, characterized in that the steam nozzle (1) and/or the arrangement for producing a water film (47) can be swept horizontally and/or is maneuverable.

26. Device according to one of Claims 14-25, characterized in that the steam nozzle (1) is a flat-spray nozzle.

27. Device according to one of Claims 14-24, characterized in that the same can be retrofitted into an existing grinding facility.

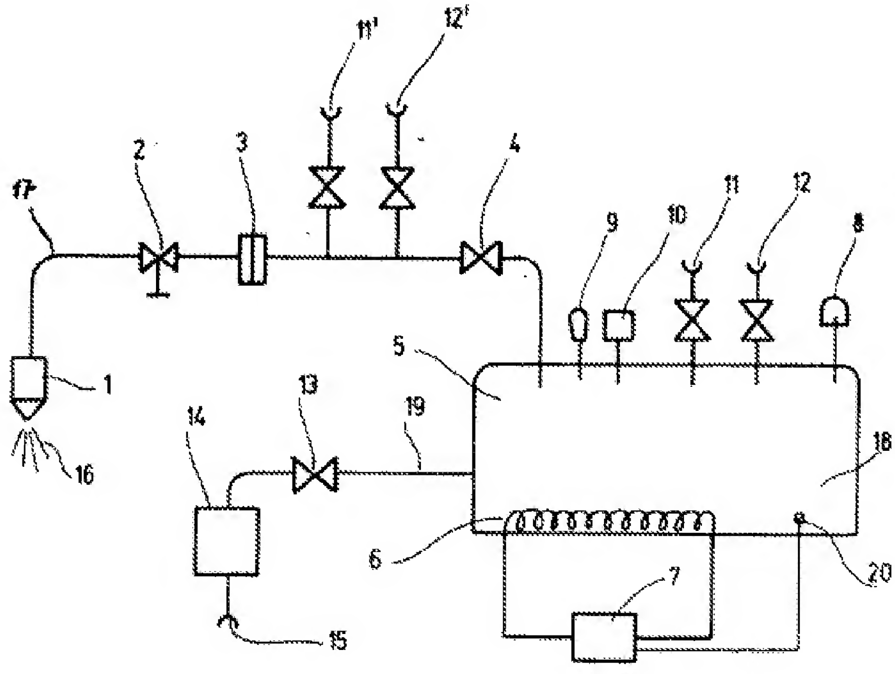


Fig. 1

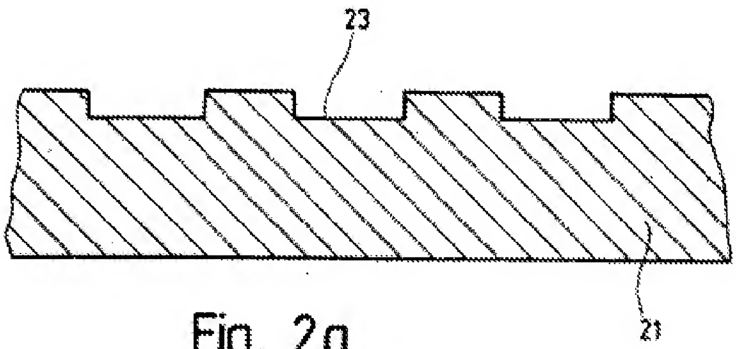


Fig. 2a

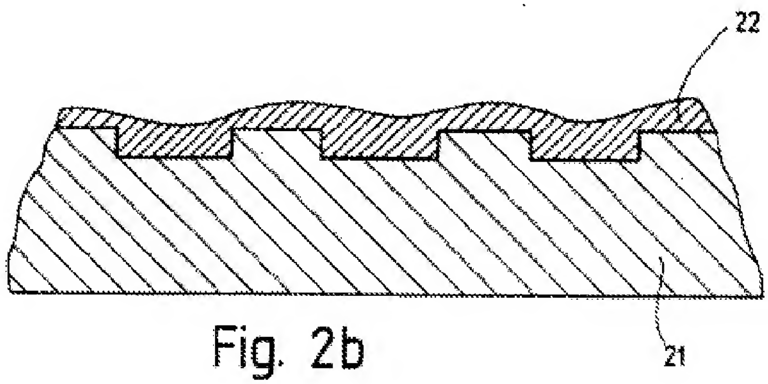


Fig. 2b

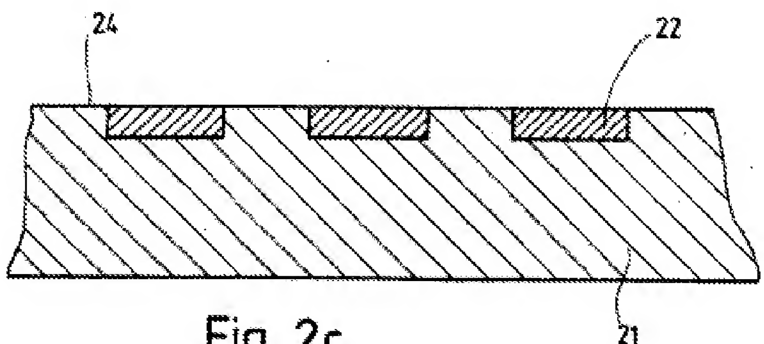


Fig. 2c

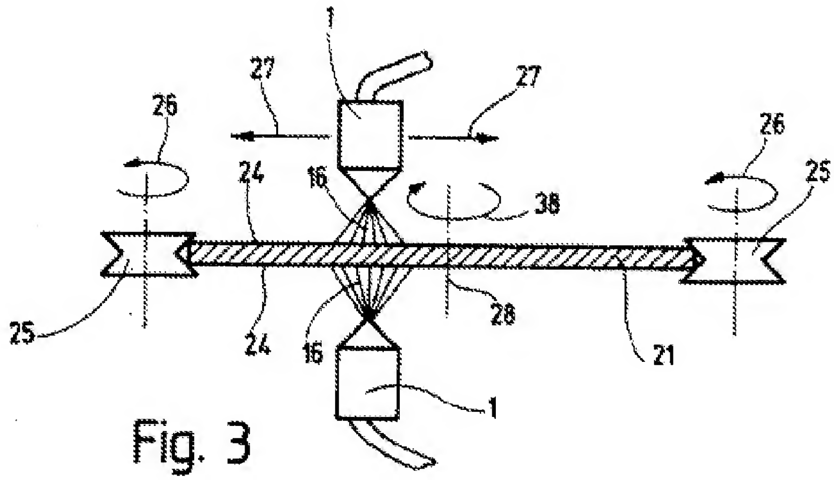


Fig. 3

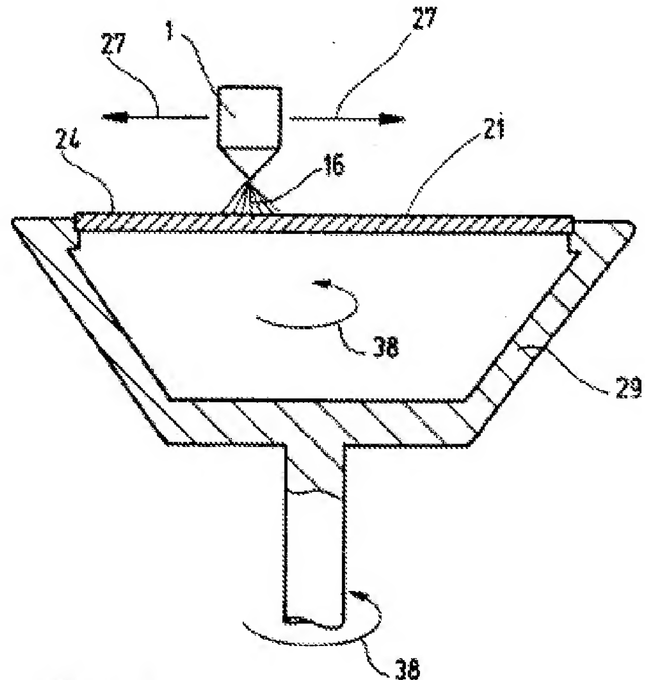
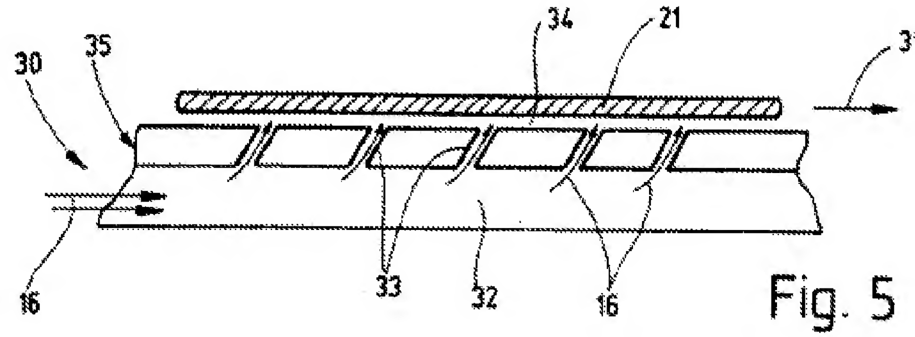


Fig. 4



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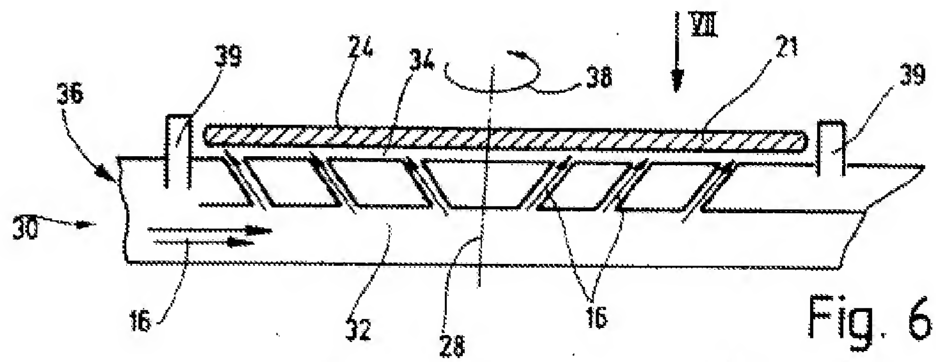

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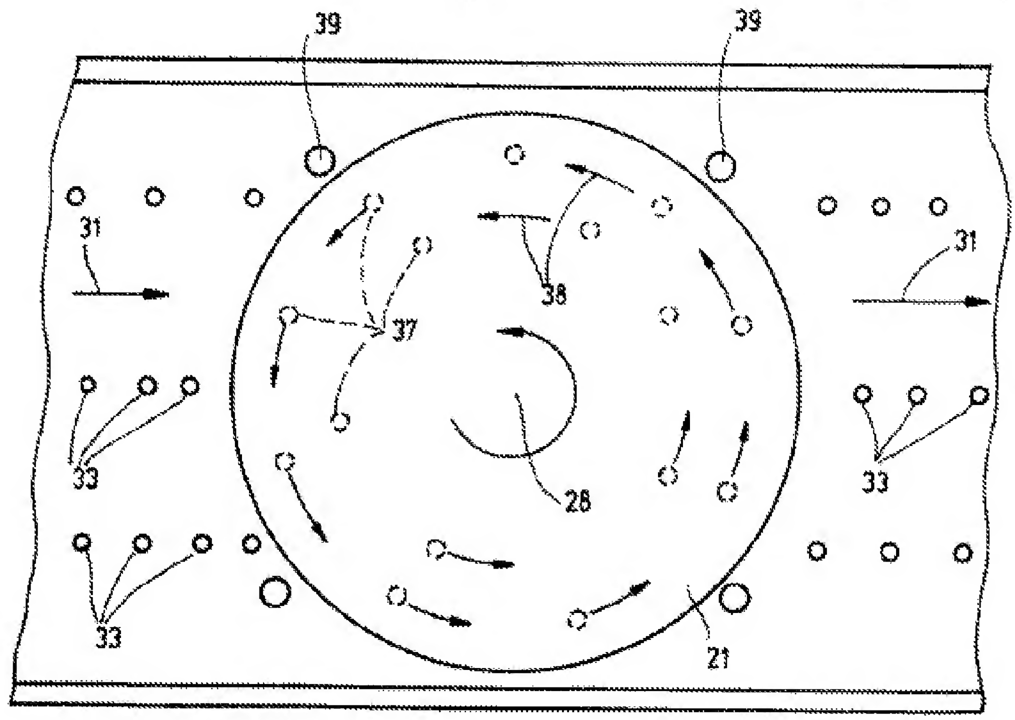

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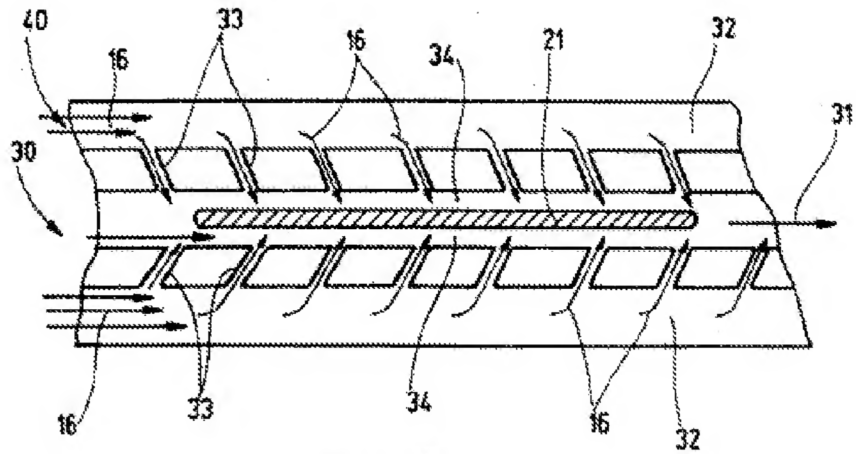

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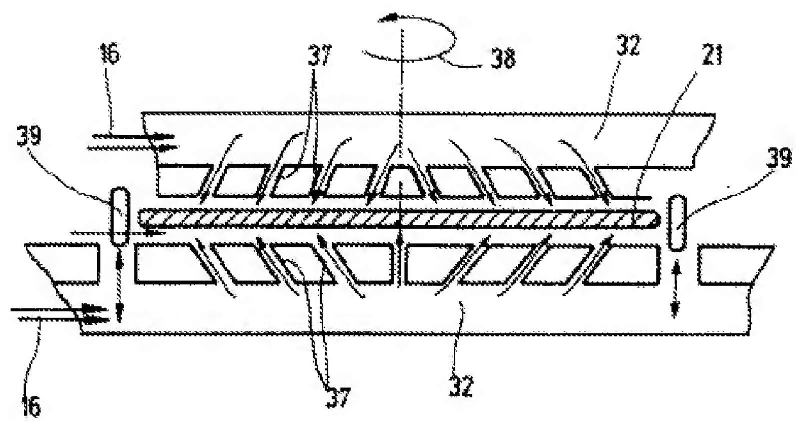

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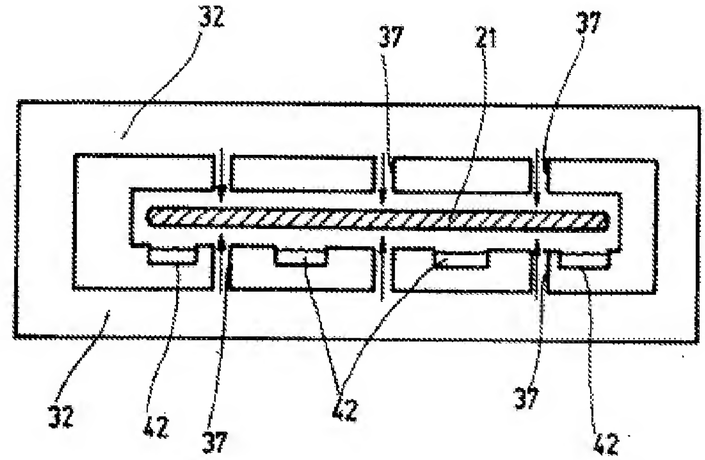
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Fig. 10

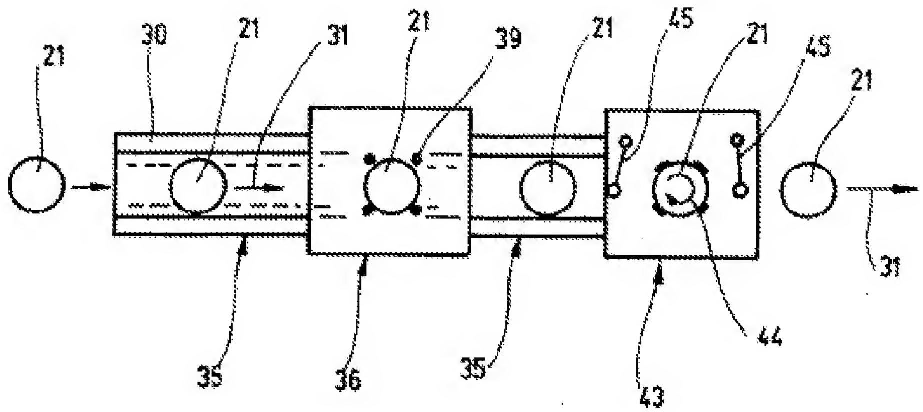
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Fig. 11

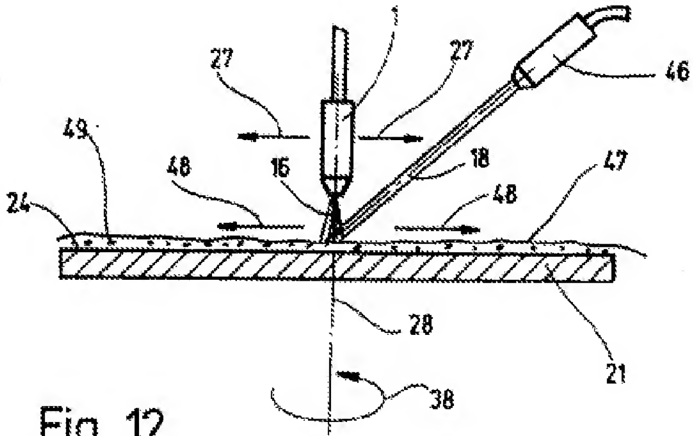

Fig. 12

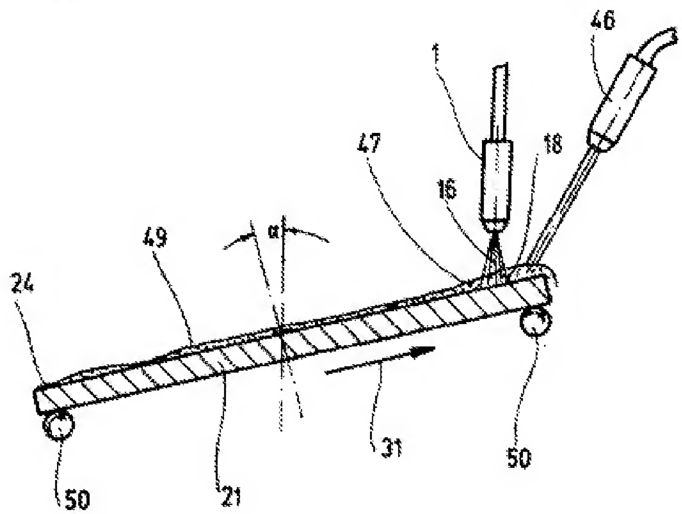

Fig. 13

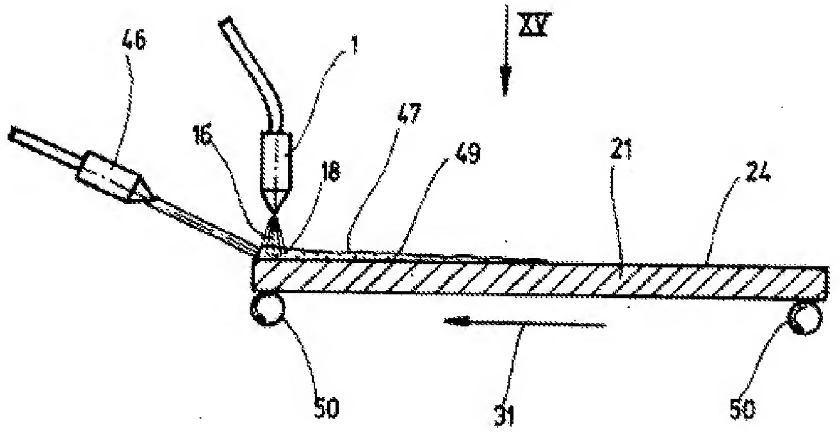

Fig. 14

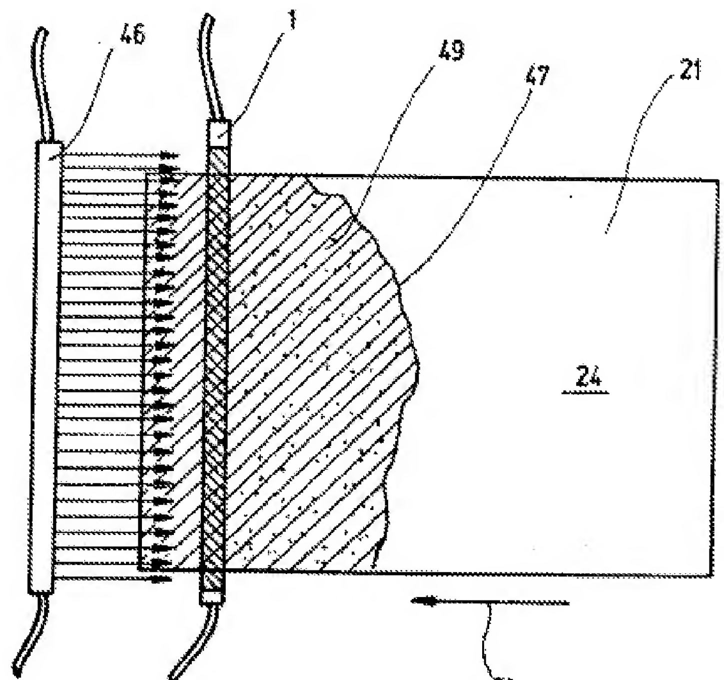

Fig. 15

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 95/03838

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B08B3/00 B08B3/02 H01L21/306 H01L21/00 B08B11/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B08B H01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	IBM TECHNICAL DISCLOSURE BULLETIN, vol. 20, no. 3, August 1977 page 959 G.A. DEIGHTON 'steam and water spray wafer cleaning' see the whole document	1-4,8,9, 11-17, 21,22
A		5-7,10, 23

X	EP,A,0 381 435 (NOKIA MOBILE PHONES LTD) 8 August 1990 see column 2, line 14 - column 4, line 13	1,2,4, 9-15

X	PATENT ABSTRACTS OF JAPAN vol. 9 no. 85 (E-308) ,13 April 1985 & JP,A,59 215729 (NIPPON SHINKU GIJUTSU KK) 5 December 1984, see abstract	1,2,4,9, 10,13, 14,25

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 February 1996	- 1 03.96

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Lilimpakis, E

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page 1 of 2

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 95/03838

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	EP,A,0 548 504 (HI-SILICON LTD) 30 June 1993 see page 5, line 33 - page 6, line 12 ---	1-3,10, 13 4
X	PATENT ABSTRACTS OF JAPAN vol. 17 no. 150 (E-1339) ,25 March 1993 & JP,A,04 315429 (HITACHI LTD) 6 November 1992, see abstract ---	1,2,9,13
A	PATENT ABSTRACTS OF JAPAN vol. 11 no. 245 (E-531) ,11 August 1987 & JP,A,62 060225 (TOSHIBA CERAMICS CO LTD) 16 March 1987, see abstract ---	1,9,10, 18
A	PATENT ABSTRACTS OF JAPAN vol. 5 no. 176 (E-81) ,12 November 1981 & JP,A,56 103439 (IMANAKA SEIJI) 18 August 1981, see abstract ---	1,9,11, 14,22
A	EP,A,0 455 465 (FUJITSU LTD) 6 November 1991 see page 2, line 37 - line 42 see page 2, line 53 - page 3, line 2 see page 8, line 36 - page 9, line 29 ---	1,2,10, 11,13
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INTERNATIONAL SEARCH REPORT

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International Application No
PCT/EP 95/03838

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